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Small Grains and Grain Sorghum

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Winter Wheat

Winter wheat is an important crop in Illinois, though its acreage in the state has recently been less than a tenth the acreage of corn. (Statewide yield trends for Illinois are shown in Figure 2.1, on p. 13.) The yield of wheat varies over years due to weather, but on a percentage basis this variability is no higher than for corn or soybean. Yields in recent years have been rising at the rate of 1.2 bushels per acre, or 2% to 3% per year. That is a faster rate, on a percentage basis, than the yield increases in corn over the same period.

Wheat grain is designated by marketing class, based on end uses for the wheat. Classes for most wheat include one of two kernel types (soft and hard) and one of two kernel colors (white and red). In addition, wheat can grow as winter wheat planted in the fall or as spring-planted wheat. These are not market classes, but nearly all spring wheat is in the hard wheat marketing class. Although all of these classes can be grown in Illinois, improved soft red winter wheat varieties are widely adapted in the state, and nearly all of Illinois wheat is of this type. The primary reasons for this are the better yields of soft red winter wheat and the sometimes-poor bread-making quality of hard wheat produced in our warm and humid climate. Because it may be difficult to find a market for hard wheat in many parts of Illinois, be sure to locate a market before planting hard wheat.

Wheat in the Cropping System

During the 1990s, wheat acreage in Illinois averaged about 1.4 million acres planted, with an average of about 1.2 million acres harvested. Since 2000, acreage has been below 1 million acres until recently; there were more than 1 million acres in 2007 and 2008. Because yields have continued to increase, the most likely explanation for the recent changes has been changing wheat prices, which have rebounded in recent years.

Most of the wheat acreage is in the southern half of the state, and a majority of the acreage south of I-70 is double-cropped with soybeans each year. Some of the crop in the northern part of the state is planted by livestock producers, who may harvest the straw as well as the grain and who often spread manure on the fields after wheat harvest. For those considering producing wheat, these points may help in making the decision:

1. State average yields have ranged from just under 50 to 67 bushels per acre over the past 10 years, with county average yields often correlated with average corn yields, reflecting the influence of soil productivity on both crops. Under very favorable spring weather conditions (i.e., dry weather in May and June), yields in some fields have exceeded 100 bushels per acre. As a rule of thumb, wheat yields average about a third those of corn, but they can be closer to half those of corn when weather is favorable for both crops. Because wheat's weather requirements differ from those of corn and soybeans, it helps spread weather risks.
2. Wheat costs less to produce than corn, but in most years gross and net incomes from wheat are likely to be less than for corn or soybeans. Added income from double-crop soybeans or from straw can improve the economic return from wheat. Wheat also provides income in midsummer, several months before corn and soybean income.
3. Wheat is one of the best annual crops in Illinois for erosion control because it is in the field for some 8-1/2 to 9 months of the year and is well established during heavy

spring rainfall. Wheat can also serve to break crop rotations that would otherwise lead to buildups in diseases or insects in corn and soybean. Some rotation research in western Illinois (see Chapter 5, "Cropping Systems") has shown that both corn and soybean yields benefit to a small extent when wheat is included in the rotation.

4. Wheat crop abandonment is higher than for other crops, but wheat acres not harvested can be planted to spring-seeded crops, usually at their optimal planting times.

Plant Development

Winter wheat typically emerges about a week after planting in the fall and grows mostly by forming tillers as the weather cools in late fall, reaching a height of only 3 to 4 inches. The growing point, or tip of the stem, remains underground through the dormant period. Growth resumes as air and soils warm in the spring, and growth becomes upright, followed by *jointing*, the point at which nodes of the stem start to become visible as the stem length increases. As the stem elongates, the developing head at the tip of the stem eventually emerges, flowering takes place, and grain fills. Growth stages in wheat are often described using a system known as the Feekes scale, illustrated in **Figure 4.1**. Some labels for inputs such as herbicides indicate at what Feekes stage the product should be applied.

Variety Selection

There has been considerable genetic improvement in wheat yield potential and standability in the past few decades, through efforts by both university and private breeders. The University of Illinois variety testing program in the Department of Crop Sciences annually tests dozens of varieties, with results available by mid-July each year at the website vt.cropsci.illinois.edu. Tests are grouped into two regions, one for northern Illinois and one for southern Illinois, each with three locations. Yield data are the most important, and height and test weight data are included as well. Test weight is an important grain quality indicator for wheat, and low test weight can result in lower prices paid for the crop. The main reason for low test weight is the presence of diseases, such as Fusarium head scab, that result in light kernels and lower kernel density.

There are occasional questions about the feasibility of producing wheat types other than soft red winter wheat in Illinois. Hard wheat classes, including hard red and hard white winter wheat, will grow well and produce good yields in Illinois, but they usually don't yield as well as soft wheat varieties and don't have the high quality needed to earn maximum price premiums over soft red wheat. Soft white wheat varieties also do well in Illinois, but the market for soft white wheat is limited, in part because soft white wheat grows so well in the Pacific Northwest and is exported from there. There is likely to be no premium for growing this type of wheat in Illinois, so there's no advantage to growing it unless a niche market can be located or developed.

Wheat producers who get a large part of their income from the crop by selling straw often choose varieties based on

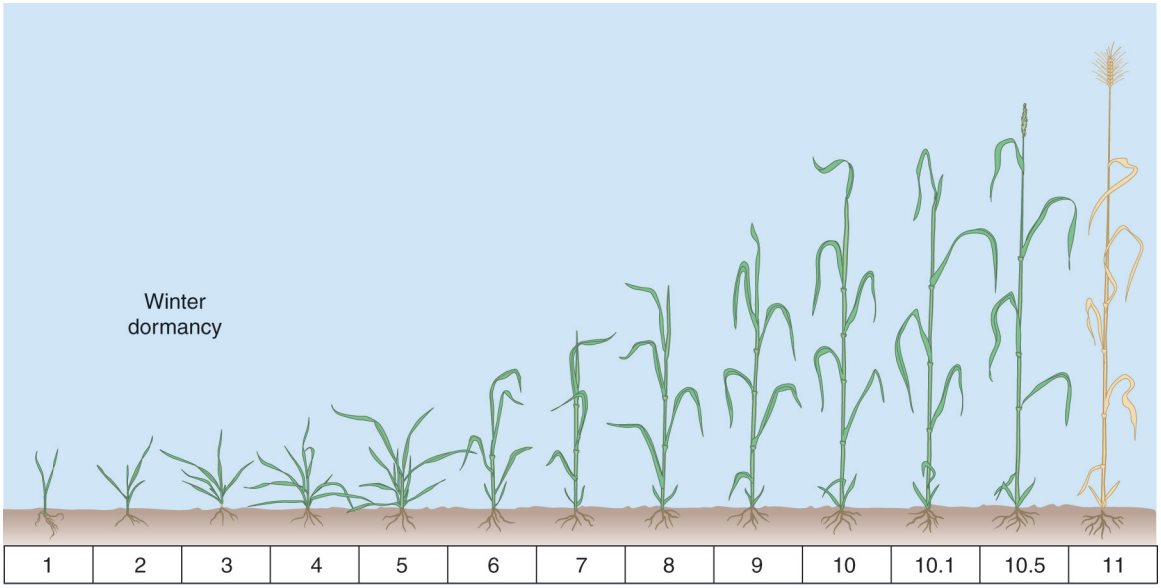

Figure 4.1. Growth stages of wheat, with Feekes' growth stage numbers indicated. Stages 1 through 3 are vegetative stages; 4 and 5 mark the start of stem growth; 6 and 7 are the "jointing" stages; 8 and 9 mark the appearance and full emergence of the flag (uppermost) leaf. Stage 10 is full "boot" stage just before head emergence, and stages 10.1 through 11 mark head emergence, flowering, and grain development through maturity.

their straw yield as much as on grain yield. In a study we did at DeKalb, we found that straw yield was affected both by plant height and by yield. The formula to predict straw yield based on height and grain yield was as follows:

Straw yield (tons per acre) = 0.018 × grain yield (bushels per acre) + 0.09 × height (inches) – 2.23

So a crop that produces 85 bushels per acre and is 35 inches tall before harvest might be expected to produce 2.45 tons of dry straw per acre (0.018 × 85 + 0.09 × 35 – 2.23). This worked well for the varieties we used in this trial, but it could be less accurate for other varieties. The important points are that higher-yielding varieties tend to have more heads per acre and so more straw and that height alone is not the best way to choose varieties, whether for grain or straw production.

Seeding Date

Hessian fly is a pest of wheat that lays its eggs in young plants in the fall; its pupae overwinter, and larvae of the next generation cause damage in the spring. Scientists found many years ago that waiting to plant wheat until after the adults of the fly died was an effective management technique. There is now genetic resistance to this pest in some wheat varieties, but the "Hessian fly-free date" was found to be a good time to plant wheat from an agronomic standpoint as well. The best time to plant wheat is the one that allows the crop to emerge and to grow for several weeks before low temperature brings on dormancy, but not so early that the crop makes excessive growth. The ranges of Hessian fly-free dates for different areas of Illinois are shown in **Figure 4.2**.

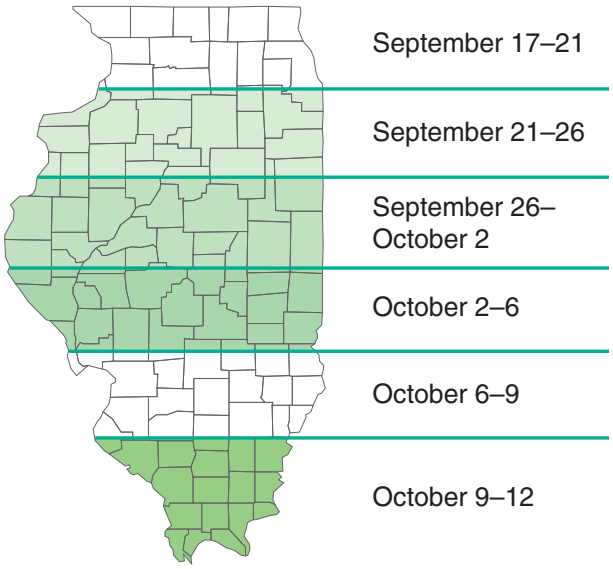

Figure 4.2. Ranges of Hessian fly-free dates in Illinois.

Wheat planted on or after the fly-free date is unlikely to be damaged by the Hessian fly, but a more important reason not to plant too early is that aphids that can carry barley yellow dwarf virus (BYDV) are much more likely to move into early-planted wheat. A crop planted at the correct time will also be less subject to damage in the fall from diseases such as Septoria leaf spot, which are favored by the excessive fall growth usually associated with too-early planting. Because the aphids that carry BYDV and the mites that carry the wheat streak mosaic virus are killed by freezing temperatures, the effects of the viruses will be less severe if wheat is planted a few weeks before the first killing freeze. Finally, wheat planted on or after the fly-free date will probably suffer less from soilborne mosaic; many varieties of soft red winter wheat carry resistance to this disease, but some show symptoms if severely infested.

Decreases in yield as planting is delayed past the fly-free date vary considerably over years and locations. In southern Illinois, the previous corn or soybean crop might be harvested several weeks before the optimum wheat planting time, and planting wheat too early is a more common mistake than planting too late. Fall aphid flights and volunteer wheat that serves as a reservoir for viral disease are more common in southern Illinois, and they add to the danger of yield loss if wheat is planted too early. Studies have shown that yields often decline little with planting delays for the first 10 days after the fly-free date. From 10 to 20 days late, yields decline at the rate of 1/2 to 1 bushel a day. The loss accelerates to 1 to 2 bushels a day from 20 to 30 days late, with sharper declines in the northern part of the state. Wheat planted a month after the fly-free date typically yields 2/3 to 3/4 of normal, and this is considered about the latest practical date to plant wheat.

Planting date has a major effect on the winter survivability of the wheat plant. It is best if the plant can grow to about the 3-leaf stage and form two or three tillers. Such plants should provide good ground cover by mid- to late November, when growth slows due to cold temperatures and dormancy sets in. Wheat may survive the winter even if planted so late that it fails to emerge in the fall, but reduced tillering and marginal winterhardiness often result in yield decreases, unless weather during the winter and spring is unusually benign.

By the time the plant reaches this growth stage, it has stored some sugars in the crown (lower stem). These sugars act as antifreeze, allowing the crown and new buds to survive soil temperatures at the crown depth down to 15 °F or so. Snow cover is very valuable, as it insulates the soil and keeps temperatures at this depth (about 1 inch) from falling this low. Late-planted wheat does not have time to produce and store as much sugar before soils freeze, while early planting tends to result in rapid plant growth with less storage of sugars. Freeze–thaw cycles during the winter

tend to use up stored sugars, thereby decreasing winter-hardiness. Varieties also differ in the ability to survive low temperatures, but many of the higher-yielding varieties begin growth early in the spring, and this trait tends to be associated with less winter-hardiness.

Some are concerned that late-planted wheat or a crop that experiences a mild winter may not grow normally and produce grain in the spring. Winter annuals such as winter wheat usually require *vernalization*, which is a period of low temperatures during which biochemical changes in the plant make it able to elongate its stem and produce a head when the weather warms in the spring. This is how the crop avoids starting to head out in the fall if planted early or when the fall is unusually warm. Wheat needs temperatures down to only about 35 to 40 °F, and for only a few weeks after the seed takes on water, to undergo vernalization. This explains why even wheat planted so late that it fails to emerge in the fall almost always produces grain in the spring.

Seeding Rate

While seeding rate recommendations for wheat have typically been expressed as pounds of seed per acre, differences in seed weight means that rate in pounds does not translate well to number of seeds per acre. Research in Illinois has measured yields in response to varying the seeding from 20 to 50 seeds per square foot. Results given in **Figure 4.3** show that highest yields required seeding rates of 35 to 40 seeds per square foot, or about 1.5 to 1.7 million seeds per acre. This is somewhat higher than previous work has shown, due in part to a late spring freeze in 2007 that reduced the per-plant yield. Fewer seeds will be adequate in some years, but planting 1.5 million seeds is a reasonable goal if planting on time. If there are 15,000 seeds per pound, then 100 pounds of seed contain 1.5 million seeds.

Seed size in wheat varies by variety and by weather during seed production but usually ranges from about 10,000 to 17,000 seeds per pound. **Table 4.1** converts seed rates per square foot to those per acre and per linear foot of row in 7.5-inch rows. These numbers are useful for calibrating a drill. Many seed containers now list the number of seeds per pound for that seed lot. If not, you may estimate that large seed has 11,000 to 13,000 seeds per pound, medium 14,000 to 16,000 seeds per pound, and small 17,000 to 18,000 seeds per pound. **Table 4.1** gives the pounds of seed per acre needed for various seed sizes. The seed drop calculator at iah.ipm.illinois.edu/seed_drop_calculator will help with calculating seed rate and calibrating drills. Use the table to convert seeding rates from number per square foot to number per acre or per foot of row, and amount of seed needed to plant one acre at different rates and with different seed sizes.

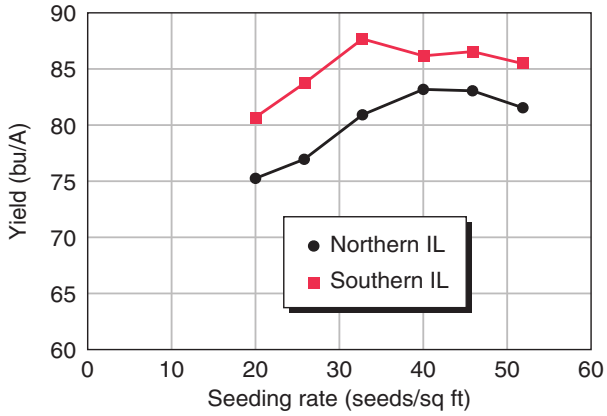

Figure 4.3. Response to seeding rate trials in northern and southern Illinois, 2007–2008.

A stand of 30 to 35 plants per square foot is generally considered optimal, and a minimum of 15 to 20 healthy plants per square foot is needed to justify keeping a field in the spring. If plants are weakened by winter weather and tiller numbers are low, then even 20 or 25 plants per square foot might not maximize yield. If in doubt, wait and count tillers. By jointing, wheat needs 40 to 50 fertile (head-bearing) tillers per square foot to ensure high yield potential.

If planting is delayed much past the fly-free date, then fall growth and spring tillering are likely to be reduced. To

Table 4.1. Conversion factors related to seeding rates for wheat.

Seeds/ sq ft	Seeds/A (millions)	Seeds/ft of 7.5-in. row	Lb of seed needed per acre				
			10,000 seeds/lb	12,000 seeds/lb	14,000 seeds/lb	16,000 seeds/lb	18,000 seeds/lb
20	0.87	13	87	73	62	54	48
25	1.09	16	109	91	78	68	61
30	1.31	19	131	109	93	82	73
35	1.52	22	152	127	109	95	85
40	1.74	25	174	145	124	109	97
45	1.96	28	196	163	140	123	109

compensate, the seeding rate should be increased by 10% for each week of delay in planting, starting two weeks after the fly-free date.

Seed Treatment

Treating wheat seeds with the proper fungicide or mixture of fungicides is an inexpensive way to help ensure improved stands and better seed quality. Under conditions that favor the development of seedling diseases, the yield from treated seed may be 3 to 5 bushels higher than that from untreated seed. See Chapter 14, "Disease Management for Field Crops," for more information.

Seed treatment insecticides have been approved for use in wheat, and their use has become more common in recent years. The major benefit provided by seed treatment insecticide is control of aphids, especially those that fly into the crop in the fall. Controlling aphids provides control of BYDV, and yield increases of more than 10 bushels per acre have been found in trials where BYDV is a serious problem. In a series of studies from 2004 through 2008, insecticide used on wheat seed in southern Illinois trials increased yield by about 6 bushels per acre, while in northern Illinois this increase was only 1.7 bushels. Seed treatment insecticide should be used only if the cost of treatment is less than the value of the additional yield produced; using this input is much more likely to be profitable in southern than in northern Illinois. Early-planted wheat is more likely to have aphids move in, and thus is more likely to benefit from seed treatment insecticide than will late-planted wheat. Whether volunteer wheat is present in the area will also affect how much disease aphids might carry, but there are some other sources of disease inoculum besides wheat.

Tillage and Previous Crop

Wheat requires good seed-to-soil contact and moderate soil moisture for germination and emergence. Generally, one or two trips with a disk harrow or soil finisher will produce an adequate seedbed if the soil is not too wet. It is better to wait until the soil dries sufficiently before preparing it for wheat, even if that means planting is delayed.

While some producers prefer to use tillage to prepare a seedbed and to improve seed-to-soil contact for wheat, others have had good success drilling wheat without tillage. This approach requires adequate weight and covering mechanisms on the drill. Other considerations for no-tilling wheat include the following: residue from the previous crop must be spread uniformly to prevent seed placement problems; without tillage to destroy emerging weeds, herbicides may need to be considered in the fall; seed rates should be on the high side of the range used for wheat; and corn residue should be allowed to dry in the morning before drilling to prevent its being pushed down into the seed furrow and reducing uniformity of seed placement.

Table 4.2 shows the results from two long-term studies in western Illinois where different rotations (corn-soybean-wheat and soybean-corn-wheat) have been grown with or without tillage for a number of years. Compared to tilled plots, yields following no-till are slightly higher at Perry, where soils are lighter, but they are somewhat lower at Monmouth. Because no-till typically has lower costs than tillage systems, no-till might be cost-effective even with slightly lower yields. No-till may also result in less soil erosion than tillage, and untilled soils may experience less saturation with heavy rainfall. No-till wheat can suffer from lower stands associated with wheel traffic. This emphasizes the need to do whatever is needed for good seed placement and uniform emergence, regardless of the tillage system used.

Results in **Table 4.2** also indicate that yields at Monmouth were 3 to 4 bushels higher following soybean than following corn. There was no such difference at Perry. One concern is that corn residue from the previous crop can provide inoculum of diseases such as Fusarium head scab, especially when wheat is no-tilled. While this may have been a factor in these studies, tilled fields and wheat following soybean have also suffered from diseases when conditions are favorable for disease development. So tillage and previous crop are not the deciding factors in how much disease develops in most cases. Getting uniform seed placement and good stands is often more important than disease potential when considering previous crop and tillage.

Depth of Seeding

Wheat should not be planted deeper than 1 to 1-1/2 inches. A good seed drill is by far the best implement for placing seed at the right depth, and nearly all wheat acres are planted using a drill. Using a fertilizer spreader to seed wheat was once more common, but given high costs of seed and the variable success with broadcast seeding, this practice is not recommended. If it is done, success will be

Table 4.2. Previous crop and tillage effects on wheat yields in two Illinois locations.

		Tillage for wheat (bu/A)	
Location	**Previous crop**	**Tilled**	**No-till**
Perry	Soybean	77.9	79.8
	Corn	78.5	77.1
Monmouth	Soybean	86.0	80.2
	Corn	82.6	78.9

Data are from 3-year rotations with corn, soybean, and wheat and are averages over 6 years (2002–2007).

"Intensive" Wheat Management

Reports of very high wheat yields in northern Europe have increased interest in application of similar "intensive" management practice in the United States. Such practices have included narrow row spacing (4 to 5 inches); high seeding rates (45 to 50 seeds per square foot); high nitrogen rates, split into three or more applications; and routine use of foliar fungicides for disease control and plant growth regulators to reduce height and lodging. Interest in such practices in Illinois was high in the 1980s, and it has increased again following high yields in some areas in some years.

From research conducted in Illinois, it has become apparent that responses to these inputs are much less predictable in Illinois than in Europe, primarily because of the very different climatic conditions. Following is a summary of research findings to date:

1. Research in Indiana and other states shows that the response to rows narrower than 7 or 8 inches is quite erratic, with little evidence to suggest that the narrow rows will pay added equipment costs.

2. Seeding rates of 30 to 40 seeds per square foot generally produce maximum yields.

3. Increasing nitrogen beyond the recommended rates of up to 130 to 140 pounds per acre has not routinely increased yields. Splitting spring nitrogen into two or more applications has not increased yields in most cases, but it may do so if very wet weather after nitrogen application results in loss of nitrogen.

4. Although foliar fungicides are useful if diseases are found, routine use has resulted in yield increases of only 3 to 5 bushels per acre and is not always economically justified, unless disease levels are high.

5. Growth regulators are not needed to prevent lodging in modern varieties.

More recently, less intensive management packages have been promoted for higher yield and better grain quality. Some of these use tiller counting in the spring, and they tie nitrogen management to tiller counts. Foliar fungicides may also be used. While they are more likely to "work" than the European system described, these practices do not always increase yield or grain quality.

better using an air-flow fertilizer spreader for better distribution. Light tillage to incorporate the seed and to improve seed-to-soil contact may be needed, but it is often not very effective, especially if wide equipment is used that provides uneven tillage across its width. Plants that grow from shallow-placed seeds do not have as much winter-hardiness as deeper-seeded plants due to their shallow crown depth.

Row Spacing

Research on row spacing generally shows little advantage for planting wheat in rows that are less than 7 or 8 inches apart. Yield is usually reduced by wider rows, with a reduction of 1 to 2 bushels in 10-inch rows and 5 to 8 bushels in 15-inch rows. Wisconsin data show greater yield reductions in 10-inch rows, probably due to slower early growth than is common in Illinois.

Wheat Management for Best Yields in Illinois

Despite our best efforts at managing wheat, harsh winter weather, a spring freeze, or wet weather in the spring can spell disaster for the crop, and there may be little that can be done to maintain good yields. To help ensure good yields when the weather is favorable, follow these steps:

1. Choose several top varieties.
2. Apply some nitrogen and necessary phosphorus fertilizer before planting: 18-46-0 provides both nutrients.
3. Drill the seed on or near the fly-free date, using 35 to 40 seeds per square foot of good-quality seed.
4. Topdress additional nitrogen at the appropriate rate in late winter or early spring, at about the time the crop breaks dormancy and begins to green up and grow. Application to frozen soil is often done to avoid application to muddy fields. This may be unavoidable, but chances of loss are higher than when N is applied after growth resumes.
5. Scout for weeds, insects, and diseases beginning in early spring; treat for control only if necessary. Fall herbicide application, especially in no-till where weeds emerge soon after planting, might be helpful in some fields.
6. Hope for dry weather during the spring, especially during the time of heading and into the grain-filling period.

Double-Cropping and Intercropping

Much of the wheat in the southern half of Illinois is double-cropped with soybeans, and a small portion of wheat acreage is double-cropped with other crops, such as sunflower and grain sorghum. The following are a few management considerations for this cropping sequence:

1. To ensure that wheat will be harvestable as early as possible, choose a midseason or earlier wheat variety. There is not as much range in wheat maturity among available varieties as many people believe; in variety trials, the different varieties generally reach combine ripeness within the space of 3 to 4 days. Ironically, some of the more disease-resistant varieties stay green longer, and thus mature later, due to healthy leaves rather than to bred-in late maturity. Variety developers usually designate maturity according to time of flowering, which does not correspond exactly to time of harvest. We have also observed that varieties that flower 3 or 4 days earlier than average tend to yield less. It seems, therefore, that the best varieties should be chosen based on yield, only making sure that they do not mature later than average.
2. Plant wheat on time. A common rule of thumb is that for every 3 days of delay in planting time, harvest is delayed by 1 day. Do not, however, plant more than a few days earlier than the Hessian fly-free date.
3. Avoid excessive nitrogen application. Too much nitrogen can delay maturity and contribute to lodging, both of which make double-cropping more difficult.
4. Harvest as soon after combine-ripeness as the weather permits. Some producers successfully harvest at grain moisture contents up to 20%, taking care not to damage kernels. A few producers have stripper-headers that remove the grain without cutting plants, making early harvest easier. If the weather is dry and warm, "early" harvest may be only 2 to 4 days earlier than usual, but this can sometimes provide enough time to plant the double crop before wet weather sets in. Wheat at these moisture contents can usually be dried using unheated air, but watch stored grain carefully to make sure it is drying. If the weather is wet or cooler than normal, it may be necessary to raise the air temperature by 10 or 15 degrees to get the crop to dry without the grain heating up.
5. If straw is not harvested, it should be chopped and spread evenly to minimize interference with planting.

There continues to be some interest in a system called *relay intercropping*, in which wheat is typically planted in rows 14 or 15 inches apart and soybean seed is then planted between these rows before the wheat crop is harvested. Relay intercropping was developed during the 1970s but has never been widely used in Illinois. A polymer seed coating marketed to delay water uptake and germination of soybean seeds, thus allowing them to be planted between wheat rows earlier than uncoated seed could be, has not worked very well. Soybeans planted too early in this system grow up through the wheat, and these plants both interfere with wheat harvest and yield less if their tops are cut off when wheat is combined.

Relay intercropping is not in wide use, and the fact that most of the wheat in Illinois is grown where double-cropping is common will probably limit its adoption. Wheat yields in wide rows are reduced, weed control is an issue, and soils under a wheat crop are often very dry, limiting emergence and growth of soybean. The presence of the soybean crop may rule out straw harvest and manure application. It is possible to use uncoated seed and to plant after heading, but this can damage wheat yields even more. When it is wet in June and soybean grows up through the wheat crop, wheat cannot be harvested without damage to the soybean crop. In summary, Illinois producers need to be cautious when considering the relay-intercropping system. Some producers in Indiana and Ohio use it, but unlike Illinois, both of those states have considerable acreages of wheat on heavier soils in their northern areas, where double-cropping cannot normally be done successfully.

Spring Wheat

Spring wheat is not well adapted to Illinois. Because it matures more than 2 weeks later than winter wheat, it is in the process of filling kernels during the hot weather typical of late June and the first half of July. Consequently, yields average only about 50% to 60% of those of winter wheat. Livestock producers sometimes inquire about producing spring wheat if winter wheat could not be planted or if it was winter-killed, especially if straw production is a major reason for growing wheat. Straw yield of spring wheat is likely to be closer to that of winter wheat than is grain yield, but spring oats will often produce as much straw as spring wheat and will often produce more income from grain.

All available spring wheat varieties are of the hard wheat type, meaning that usefulness for breadmaking is an important quality (and price) consideration. Besides yield challenges for spring wheat in Illinois, getting price premiums based on high protein is unlikely in our soils and climate. Niche markets for hard wheat may exist, but in most cases the need for good-quality hard wheat is met by bringing wheat from drier areas such as the Great Plains or Canadian prairies.

With the exception of planting time, production practices for spring wheat are similar to those for winter wheat. Because of the lower yield potential, nitrogen rates should be 20 to 30 pounds less than those for winter wheat. Spring wheat should be planted in early spring—as soon as a seedbed can be prepared, at about the same time as spring oats is planted. If planting is delayed beyond mid-April,

yields are likely to be low, and another crop should be considered.

Very little spring wheat is grown in Illinois, and there has been little recent testing of spring wheat varieties. Most spring wheat varieties that may grow reasonably well in Illinois were bred in Minnesota or other northern states, and so there is some risk when they are grown here. There are no varieties known to be clearly superior for either yield or quality when grown in Illinois, but those used widely in Minnesota are likely the best choices for growing in northern Illinois.

Rye

Both winter and spring varieties of rye are available, but only the winter type is suitable as a grain crop in Illinois. Winter rye is often used as a cover crop to prevent wind erosion of sandy soils. The crop is very winter-hardy, grows late into the fall, and is quite tolerant of drought. Rye generally matures 1 or 2 weeks before wheat. The major drawbacks to raising rye are the low yield potential and the very limited market. Rye is less desirable than other small grains as a feed grain.

The cultural practices for rye are similar to those for winter wheat. Planting can be somewhat earlier, and the nitrogen rate should be 20 to 30 pounds less than for wheat because of lower yield potential. Watch for shattering as grain nears maturity. Watch also for the ergot fungus, which replaces grains in the head and is poisonous to livestock. Ergot can develop when the weather is wet at heading.

There has been very little development of varieties specifically for the Corn Belt, and no formal yield testing has been done recently in Illinois. Much of the rye seed available in Illinois is simply called common rye; some of this probably descended from Balbo, a variety released in 1933 and widely grown many years ago in Illinois. More recently developed varieties that may do reasonably well in Illinois include Hancock, released by Wisconsin in 1979, and Rymin, released by Minnesota in 1973. Spooner is another Wisconsin variety that may be suitable.

Triticale

Triticale is a crop that resulted from the crossing of wheat and rye in the 1800s. The varieties currently available are not well adapted to Illinois and are usually deficient in some characteristic such as winter-hardiness, seed set, or seed quality. In addition, they are of feed quality only. They do not possess the milling and baking qualities needed for use in food products, though there are still some efforts underway to improve grain quality for this purpose.

Cultural practices for triticale are much the same as those for wheat and rye. The crop should be planted on time to help winter survival. As with rye, the nitrogen rate should be reduced to reflect the lower yield potential. With essentially no commercial market for triticale, growers should make certain they have a use for the crop before growing it. Generally when triticale is fed to livestock, it must be blended with other feed grains. Triticale is also used as a forage crop. The crop should be cut in the milk stage when it is harvested for forage.

A limited testing program at Urbana indicates that the crop is generally lower yielding than winter wheat and spring oats. Both spring and winter types of triticale are available, but only the winter type is suitable for Illinois. Caution must be used in selecting a variety because most winter varieties available are adapted to the South and may not be winter-hardy in Illinois. Yields of breeding lines tested at Urbana have generally ranged from 30 to 70 bushels per acre.

Spelt

Spelt is a very old type of wheat that was grown thousands of years ago. It has recently gotten some attention as a more nutritionally complete grain in comparison to regular wheat. It is grown like winter wheat and tends to be quite winter-hardy. It is used as livestock feed and is processed into food products. As in oats, the hull of spelt remains attached until the grain is processed for food. One advantage spelt has over wheat is that it will grow in a wider range of soil conditions, including droughty or wet soils. Yields are not likely to be as high as those of wheat, and the crop can suffer from a number of diseases. Niche markets for organic spelt exist in some places, and there are some small variety improvement programs underway.

Oats

Spring oats were once grown on more than 3 million acres in Illinois, primarily for use as horse and pig feed. In recent years less than 100,000 acres of oats has been grown in Illinois, and some of that is seeded with a legume to provide some cover during slow early growth of the legume, then is harvested as forage.

Even though oats has become a small-acreage crop in Illinois, the University of Illinois continues to develop varieties, which unlike wheat are still sold as public varieties. Oat yields in Illinois trials are reported along with wheat yields at the website vt.cropsci.illinois.edu/wheat.html. Test weight is an important grain quality trait for oats,

especially for sale as horse feed. For processing into food products such as oatmeal, groat percentage—the percentage of hulled kernel compared to unhulled seed—may be more important than test weight.

To obtain high yields of spring oats, plant the crop as soon as you can prepare a seedbed. Yield reductions become quite severe if planting is delayed beyond April 1 in central Illinois and beyond April 15 in northern Illinois. After May 1, another crop should be considered unless the oats are being used as a companion crop for forage crop establishment and yield of the oats is not important.

When planting oats after corn, it is often desirable to disk the stalks; plowing may produce higher yields but is usually impractical. When planting oats after soybeans, disking is usually the only preparation needed, and it may be unnecessary if the soybean residue is evenly distributed. Make certain that the labels of the herbicides used on the previous crop allow oats to be planted; oats are quite sensitive to a number of common herbicides.

Before planting, treat the seed with a fungicide or a combination of fungicides. Seed treatment protects the seed during the germination process from seed- and soilborne fungi. (See Chapter 14 on disease management.)

Oats may be broadcast and disked in but will yield 7 to 10 bushels more per acre if drilled. When drilling, plant at a rate of 2 to 3 bushels (64 to 96 lb) per acre. If the oats are broadcast and disked in, increase the rate by 1/2 to 1 bushel per acre. As a companion seeding with forage legumes, use only 1 to 1-1/2 bushels per acre.

For suggestions on fertilizing oats, see Chapters 8 and 9.

Winter oats are not nearly as winter-hardy as wheat and are likely to survive mild winters only in the southern third or quarter of the state; U.S. Highway 50 is about the northern limit for winter oats. Because winter oats are not attacked by Hessian fly, planting in early September is highly desirable. Barley yellow dwarf virus may, however, infect early-planted winter oats, since the crop attracts aphids. Using seed-applied insecticide should provide protection against this insect and the disease it carries. The same type of seedbed is needed for winter oats as for winter wheat. The fertility program should be similar to that for spring oats. Seeding rate is 2 to 3 bushels per acre when drilled.

Development of winter oat varieties has virtually stopped in the Midwest because of the frequency of winter kill. Of the older varieties, Norline, Compact, and Walken are sufficiently hardy to survive some winters in the southern third of the state. All of these varieties were released more than 20 years ago. Walken has the best lodging resistance of the three.

Barley

Spring barley is damaged by hot, dry weather and so is adapted only to the northern part of Illinois. Good yields are possible, especially if the crop is planted in March or early April, but yields tend to be erratic. Markets for malting barley are not established in Illinois, and malting quality may be a problem. Barley can, however, be fed to livestock.

Plant spring barley early—about the same time as spring oats. Drill 2 bushels (96 lb) of seed per acre. To avoid excessive lodging, harvest the crop as soon as it is ripe. Fertility requirements for spring barley are essentially the same as for spring oats.

The situation with spring barley varieties is similar to that for spring wheat: most varieties originate in Minnesota or North Dakota and have not been widely tested or grown for seed in Illinois. Some of these varieties are Azure, Hazen, Manker, Morex, Norbert, Robust, and Excel. Seed for any of these will likely need to be brought in from Minnesota or the Dakotas.

Winter barley is not as winter-hardy as the commonly grown varieties of winter wheat and should be considered only in the southern third or so of Illinois. It is used almost exclusively as animal feed, and acreage in Illinois is very low.

Winter barley should be planted 1 to 2 weeks earlier than winter wheat. Sow with a drill and plant 2 bushels of seed per acre. Fertility requirements for winter barley are similar to those for winter wheat except that less nitrogen is required. Most winter barley varieties are less resistant to lodging than are winter wheat varieties. Winter barley cannot stand “wet feet,” and the crop should not be planted on land that tends to stay wet. The barley yellow dwarf virus is a serious threat to winter barley production.

There is no known commercial production of winter barley seed in Illinois, but a few newer varieties are bred and produced in states like Pennsylvania and Virginia. Pennco and Wysor are two varieties released in the 1980s, and they may survive the winter in southern Illinois.

Grain Sorghum

Although grain sorghum can be grown throughout Illinois, its greatest potential, in comparison with other crops, is in the southern third of the state. It is adapted to almost all soils, from sand to heavy clay. Its greatest advantage over corn is tolerance of moisture extremes. Grain sorghum usually yields more than corn when moisture is in short supply, but under better growing conditions it usually

yields less than corn. Grain sorghum is also less affected by late planting and high temperatures during the growing season, but the crop is very sensitive to cool weather and will be killed by even light frost.

Although few side-by-side comparisons of corn and grain sorghum in southern Illinois are available, hybrid trials that were for some years conducted annually in southern Illinois offer some indication of relative yields. Averaged across six such trials, corn yielded about 40 bushels per acre more than grain sorghum, and much more than this when corn yields were high, as they have been in most years recently. In general, grain sorghum tends to yield more than corn only in fields where corn yields less than 100 bushels per acre. At the same time, average yields of grain sorghum in Illinois have been only 90 bushels per acre over the last decade and have exceeded 100 bushels only twice. In contrast, corn yields have averaged more than 150 bushels over the same period, and they have almost always exceeded grain sorghum yields, even in the same county.

It is common in many areas of the U.S. to refer to grain sorghum as "milo." Both are the same crop species, and "milo" technically refers to nonhybrid, more or less unimproved grain sorghum, grown for hundreds of years as a food crop, first in Africa, where it originated. In practice, the term *milo* is used interchangeably with *grain sorghum*. The term "sorghum" is also used to refer to sweet sorghum, used to make molasses, and to forage types of this crop, while milo refers to a crop grown for grain.

Fertilization. In general, phosphorus and potassium requirements of grain sorghum are similar to those for corn. The response to nitrogen is somewhat erratic, due largely to the extensive root system's efficiency in taking up soil nutrients. For this reason, and because of the lower yield potential, the maximum rate of nitrogen suggested is about 125 pounds per acre. For sorghum following a legume, such as soybean or clover, this rate may be reduced by 20 to 40 pounds.

Hybrids. The criteria for selecting grain sorghum hybrids are similar to those for selecting corn hybrids. Yields, maturity, standability, and disease resistance are all important. Consideration should also be given to the market class (endosperm color) and bird resistance, which may be associated with palatability to livestock. Performance tests of commercial grain sorghum hybrids are no longer conducted by the University of Illinois, so data need to come from seed companies. Much of their testing is done in states west of (and drier than) Illinois. Because of the limited acreage of grain sorghum in the eastern United States, most hybrids are developed for the Great Plains, and most have not been extensively tested under midwestern conditions. Illinois is farther north than most grain sorghum in the U.S., and so earlier-maturing hybrids tend to do better than later ones. Maturity of hybrids is expressed in days, but unlike corn, this refers to days to flowering, not days to maturity. So a "60-day" sorghum hybrid is not early, but rather midseason or even on the late side.

Planting. Sorghum should not be planted until soil temperature reaches 65 °F. In the southern half of the state, mid-May is considered the earliest practical planting date, while in northern Illinois planting should typically start only in late May. Such late planting, along with a shorter, cooler growing season, means that grain sorghum hybrids used in northern Illinois must be early maturing in order to mature before frost.

Sorghum usually emerges more slowly than corn and requires relatively good seed-to-soil contact. Planting depth should not exceed 1-1/2 inches, and about 1 inch is considered best. Because sorghum seedlings are slow to emerge, growers should use care when using reduced-till or no-till planting methods. Surface residue usually keeps the soil cooler and may harbor insects that can attack the crop, causing serious stand losses, especially when the crop is planted early in the season.

Row spacing. Row-spacing experiments have shown that narrow rows may produce more than wide rows, especially in dry years when plant growth is limited. Drilling in 7- to 10-inch rows works well if weeds can be controlled without cultivation, but if weed problems are expected, wider rows that will allow cultivation may be a better choice. Using a split-row planter to plant 15-inch rows is a good practice, providing weeds can be controlled.

Plant population. Because grain sorghum seed is small and some planters do not handle it well, this crop was historically planted based on pounds of seed per acre rather than number of seeds. This often resulted in overly dense plant populations that can cause lodging and yield loss. Aim for a plant stand of 50,000 to 100,000 plants per acre, with lower populations on droughtier soils. This is about 3 to 6 plants per foot of row in 30-inch rows at harvest and 2 to 4 plants per foot in 20-inch rows. Plant 30% to 50% more seeds than the intended stand, especially if planting early into cooler soils. Sorghum may also be drilled using 6 to 8 pounds of seed per acre if the drill cannot be calibrated more closely than this. Avoid excessive seed rates; plant stands when drilled should not be much higher than those in rows. Grain sorghum tillers extensively when plant populations are low. This increases yields, but tiller heads mature later, and it is usually better to have most of the harvested heads be primary heads, not tiller heads. Getting a uniform stand at high enough population is the way to reduce tiller formation.

Weed control. Because emergence and early growth of sorghum are slow, controlling weeds presents special problems. Suggestions for chemical control of weeds are given in Chapter 12. As with corn, a rotary hoe may be useful after the crop is rooted but before weeds become established.

Harvesting and storage. Timely harvest is important. Rainy weather after sorghum grain reaches physiological maturity may cause sprouting in the head, weathering (soft and mealy grain), or both. Harvest may begin when grain moisture is 20% or greater, if drying facilities are available. Sorghum often dries slowly in the field. Because sorghum plants do not die until frost, using a desiccant can reduce the amount of green plant material going through the combine, making harvest easier.

Marketing. Before planting, check on local markets. Because the acreage in Illinois is limited, many elevators do not buy grain sorghum.

Grazing. After harvest, sorghum stubble may be used for pasture. Livestock should not be allowed to graze for one week after frost because the danger is especially high for poisoning from prussic acid (hydrocyanic acid, or HCN). Tillers that can develop from the base of the plant after grain harvest can be very high in prussic acid after a frost.